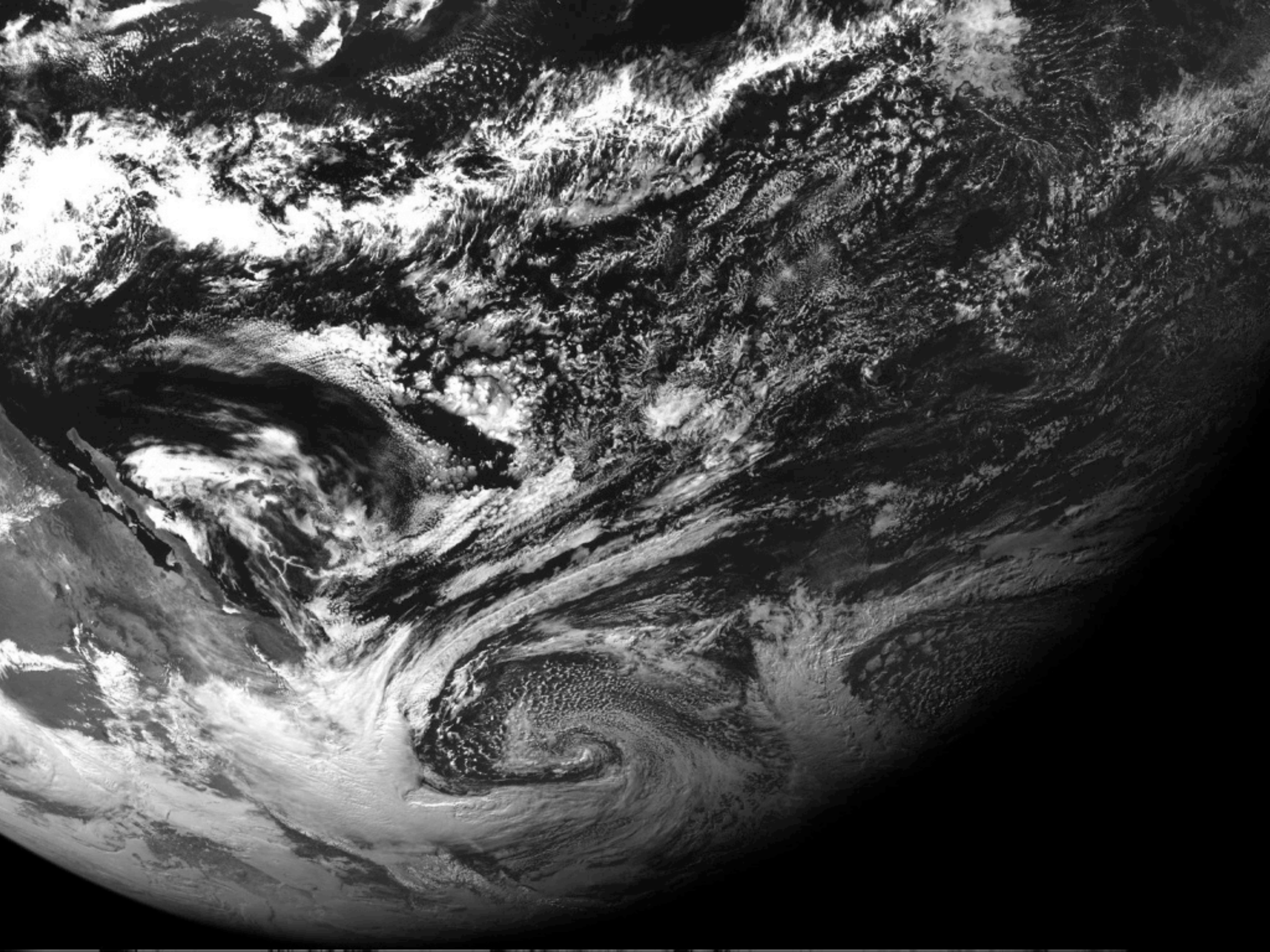
Cloud-topped Boundary Layers



- Shallow cumulus (Cu) boundary layers
- Stratocumulus (Sc)-capped BLs
- Cold-air outbreaks
- Shear-driven shallow stratus layers
- Summertime Arctic stratus

- **Shallow cumulus (Cu) boundary layers**

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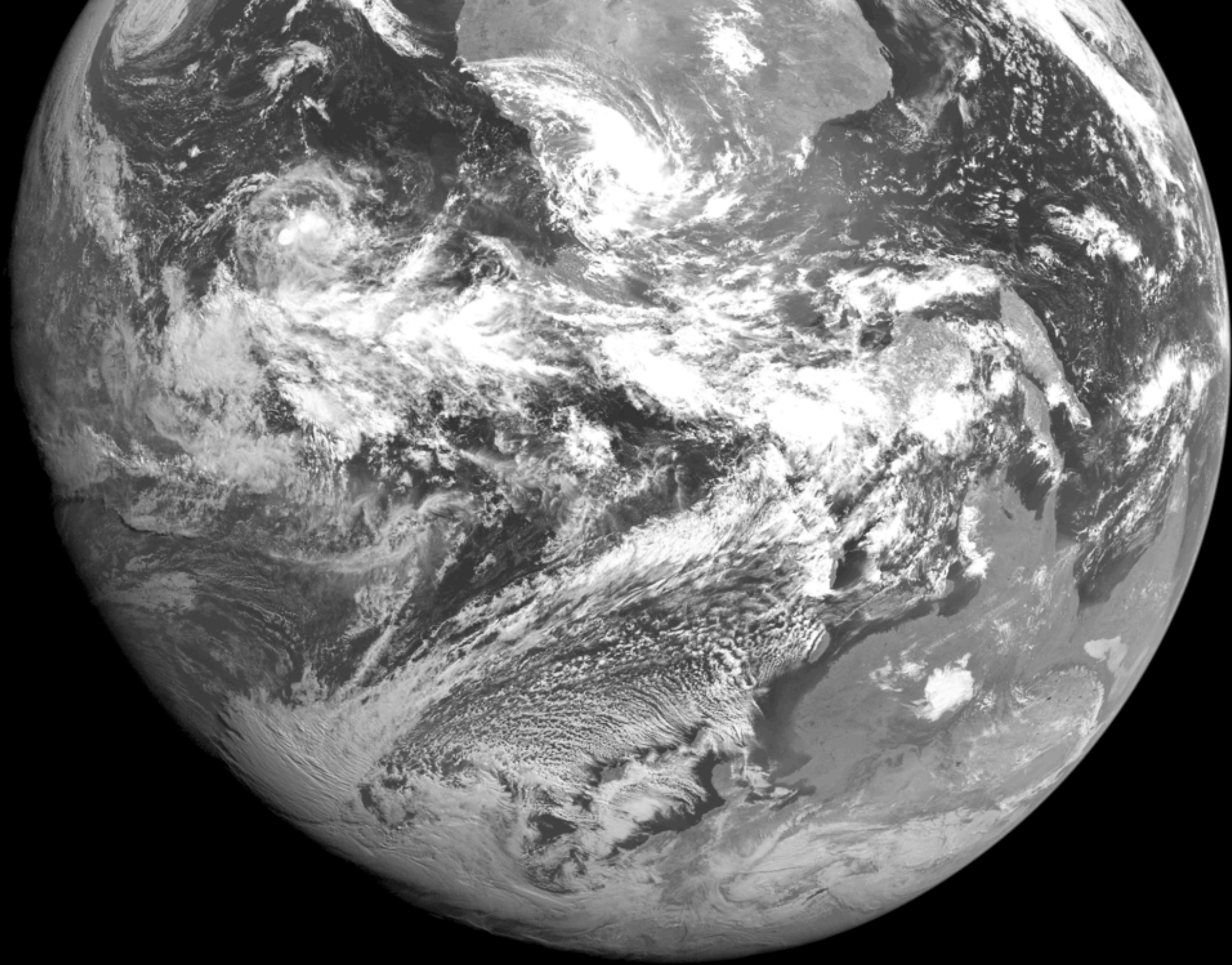
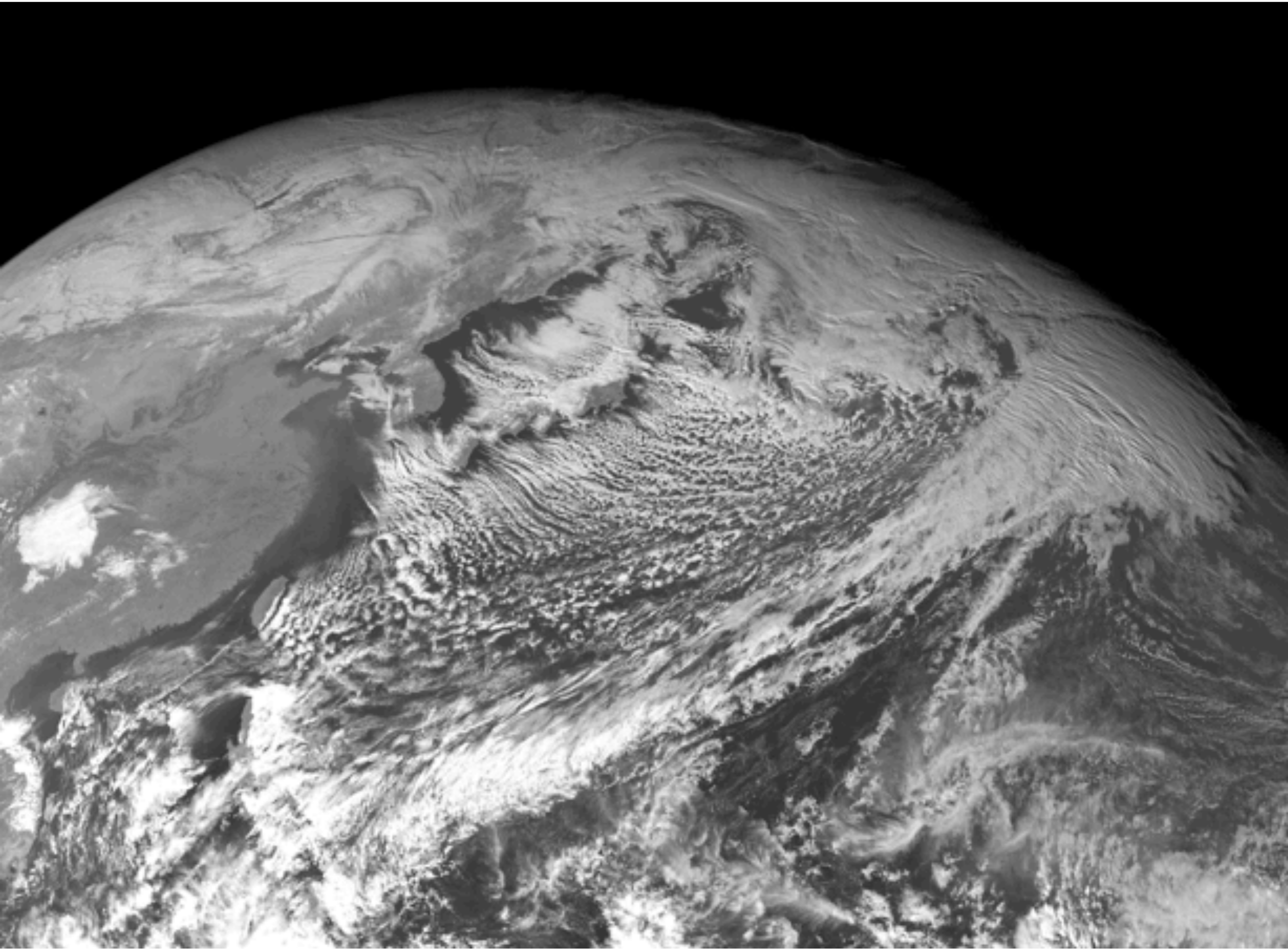
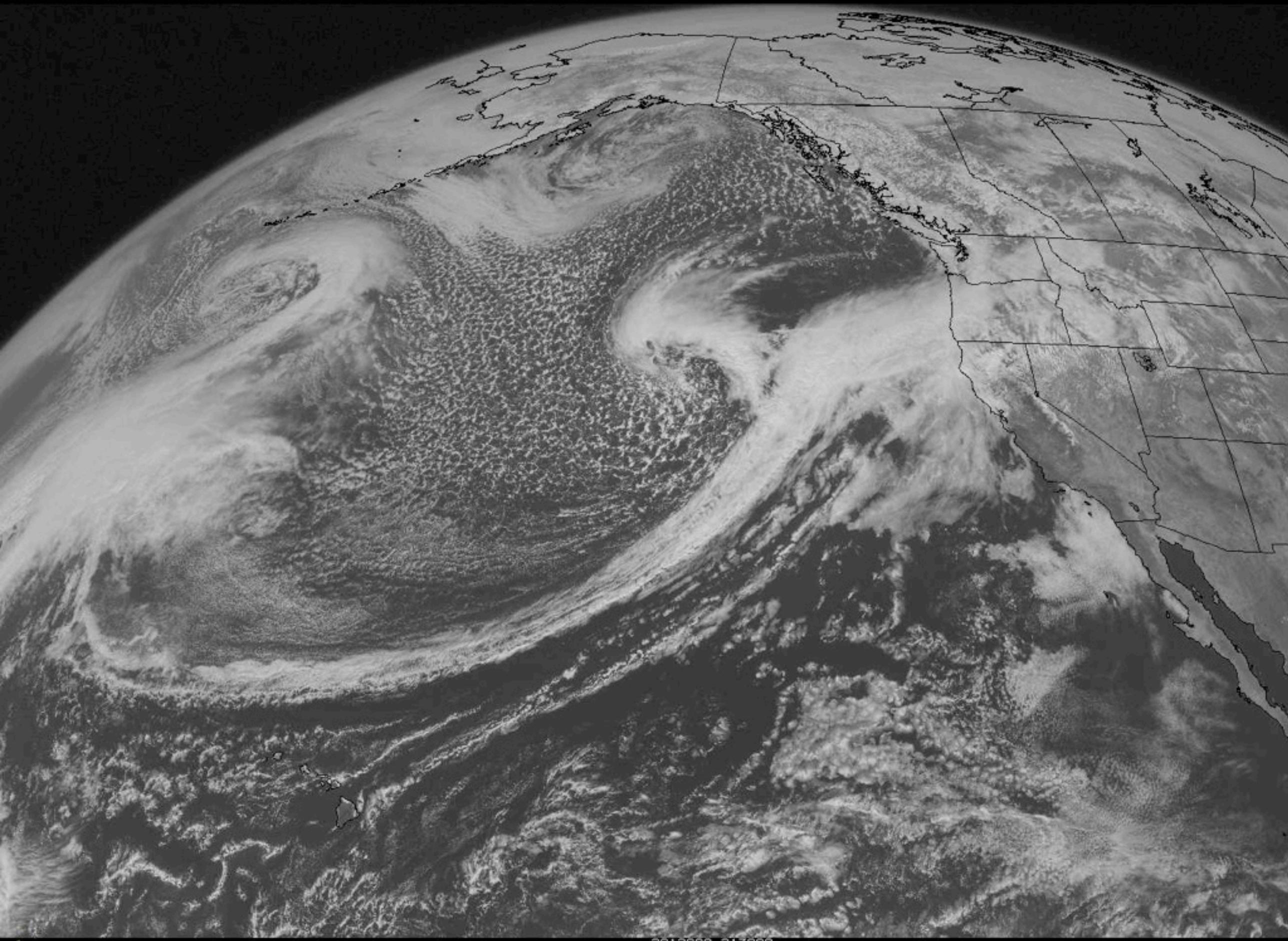




GOES WEST NORTHERN HEMISPHERE VISIBLE 30 MAR 12 21:30 SSEC: UW-MADISON



1 2012090 213000

Analysis chart valid 12 UTC SUN 31 JAN 2010

GEOSTROPHIC WIND SCALE
IN KNOTS FOR ISOBARS AT 4 MB INTERVALS
POLAR STEREOGRAPHIC PROJECTION

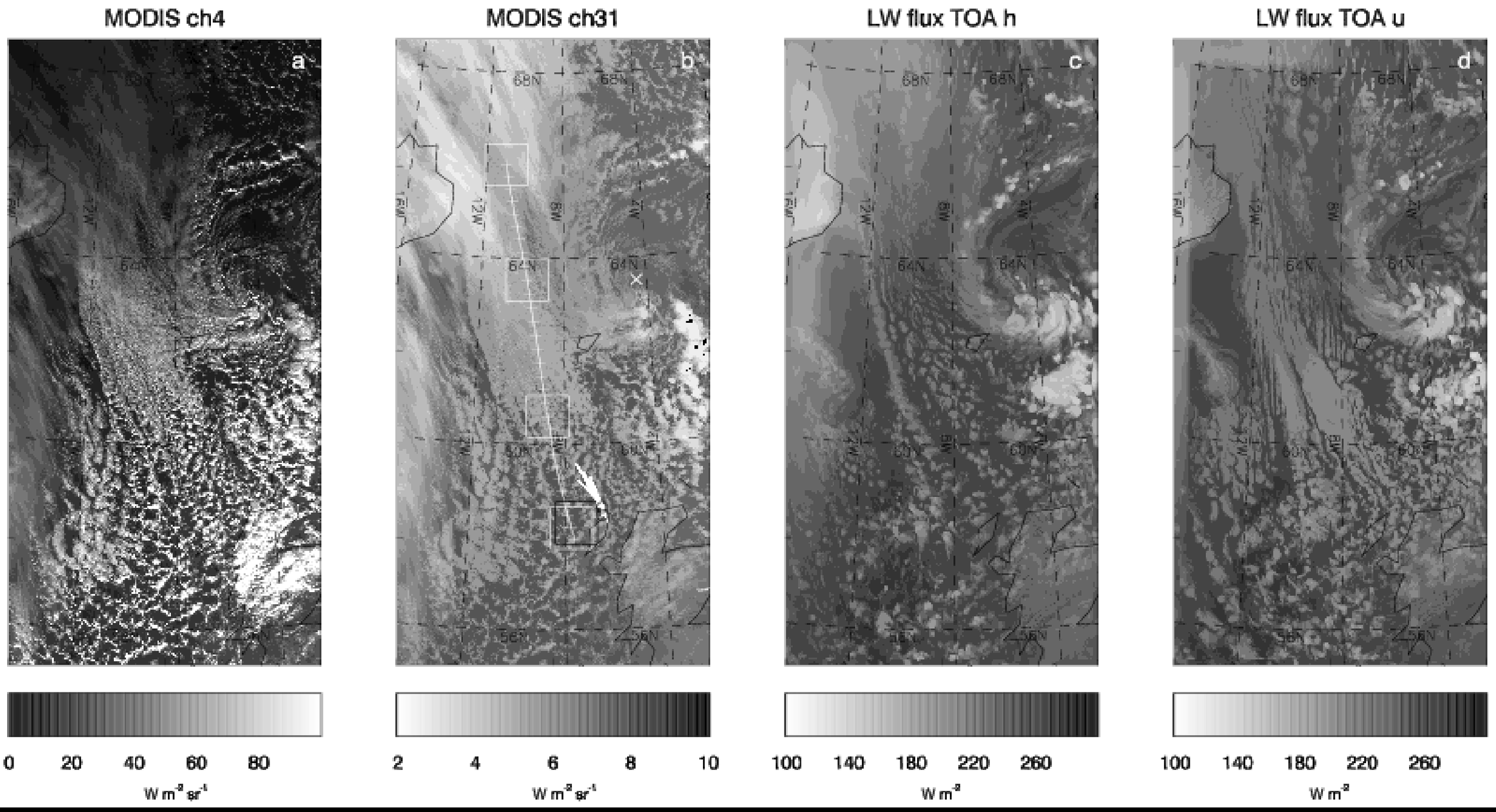
N
70
60
50
40

H 1021
H 1013
L 964
L 992
L 991
L 990
L 991
L 995
L 995
L 997
H 1011
L 1006
H 1021
H 1018

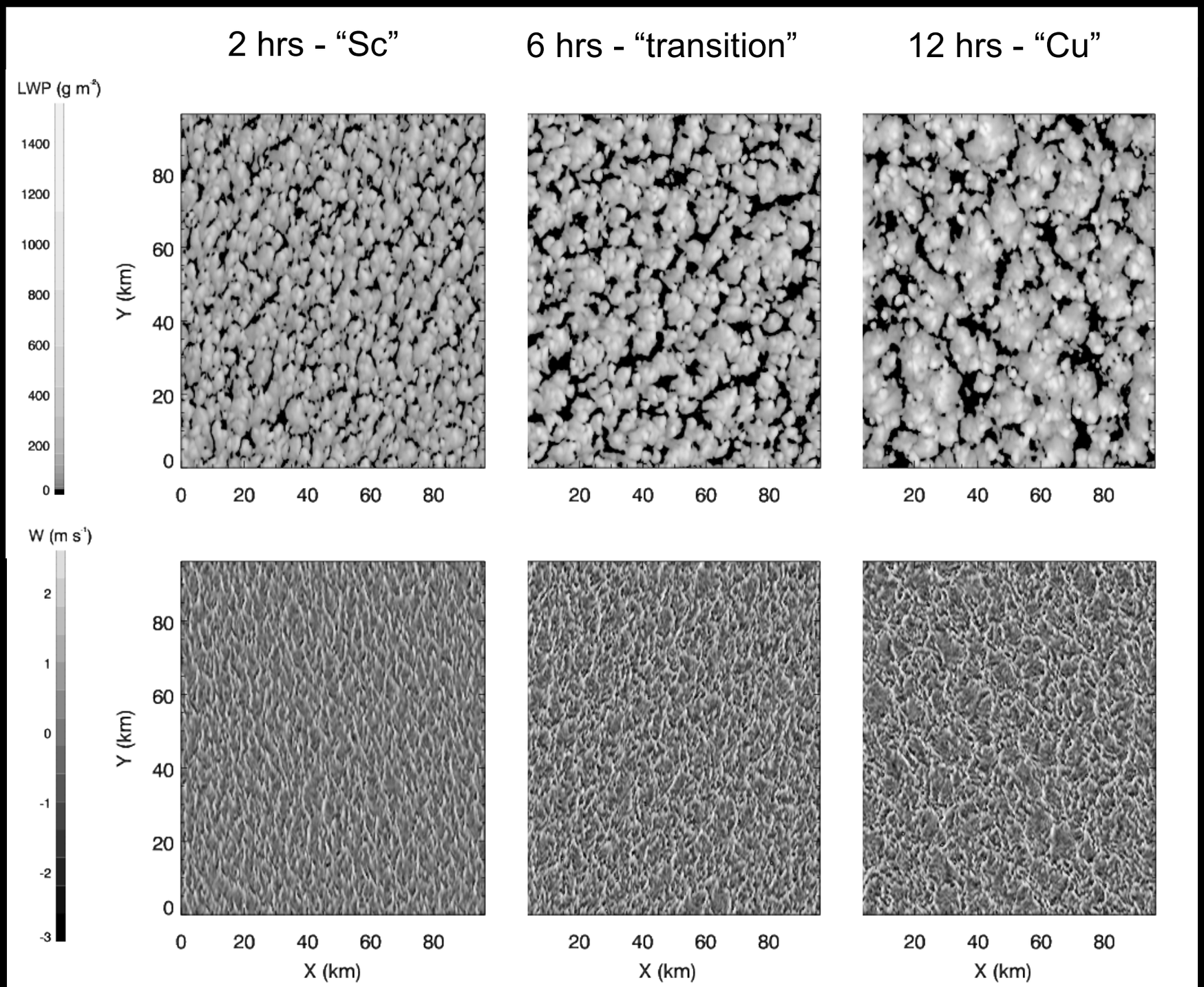
Met Office
metoffice.gov.uk

CONSTRAIN

As air advects over warmer seas the Sc transitions to mixed-phase cumulus clouds at around 60N, prior to reaching land

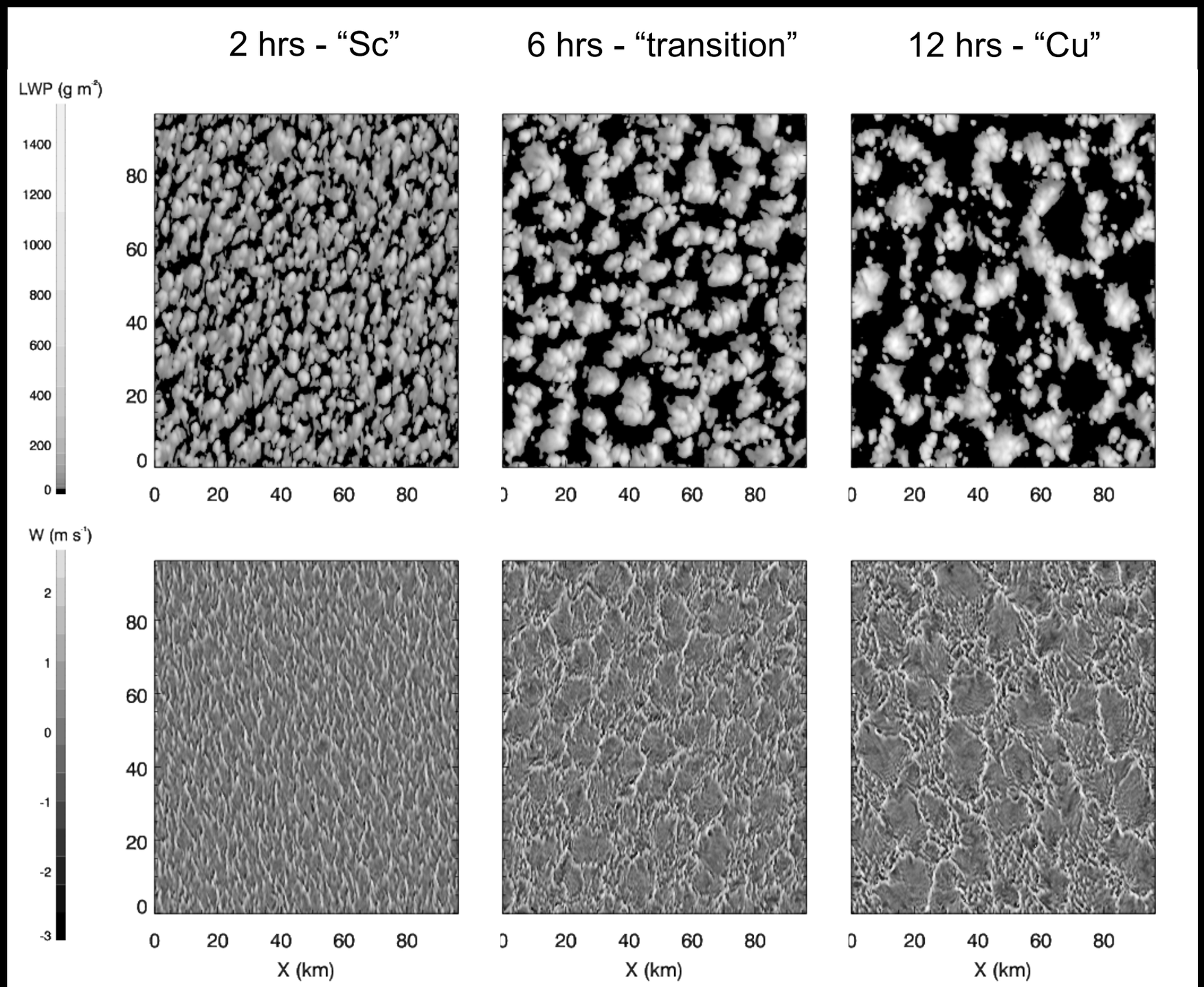


No-Ice simulation with UKMO LEM

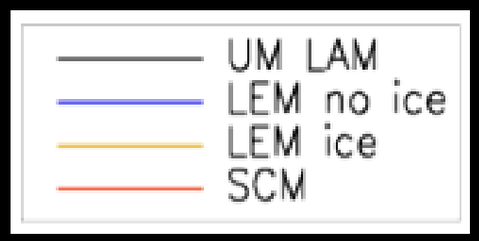


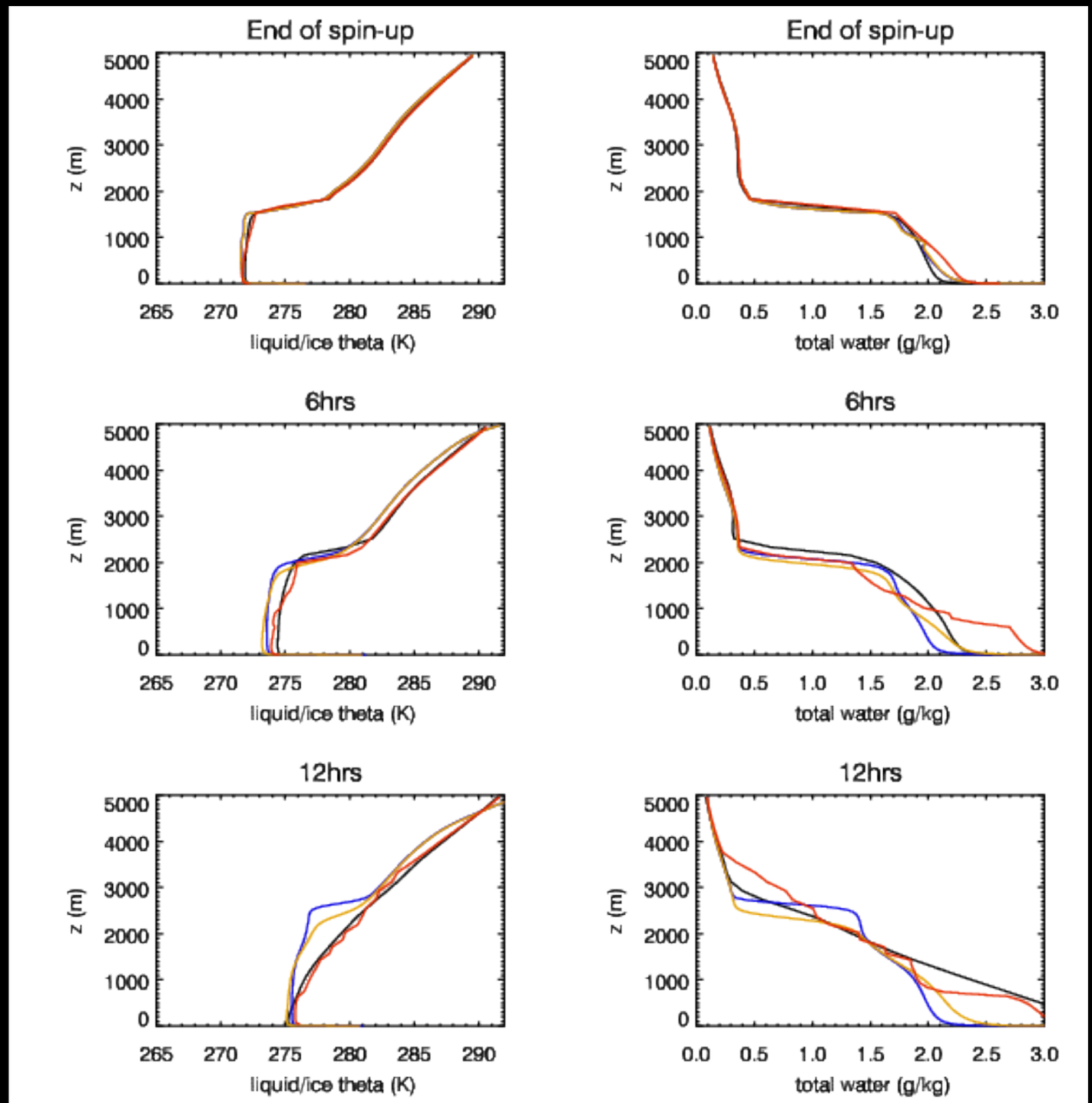
* LEM is UKMO large eddy simulation model

Ice simulation with UKMO LEM

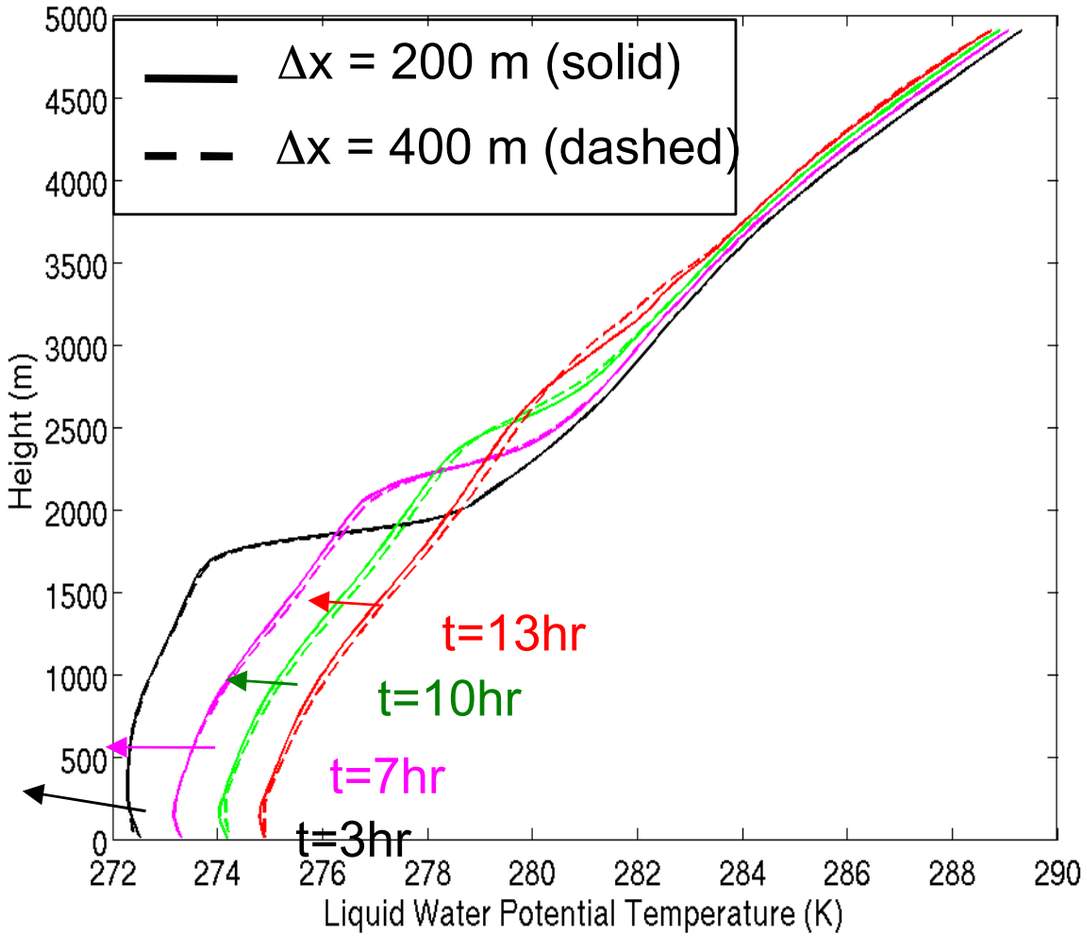


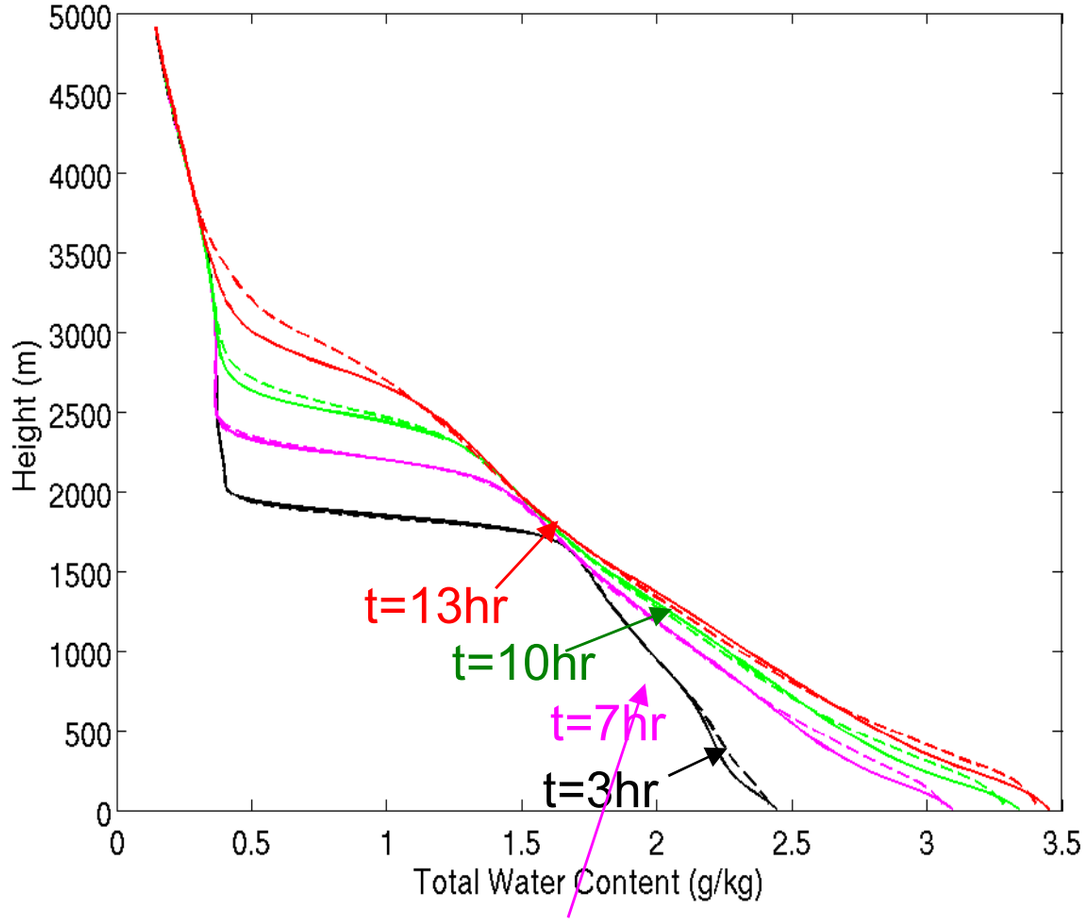
Liquid/ice potential temperature (left) and total water (right) from UM LAM, LEM, SCM





Liquid water potential temperature & total water content, Nc = 10 cm^{-3}





Coarser resolution hardly has an effect on the mean state evolution

- Shallow cumulus (Cu) boundary layers
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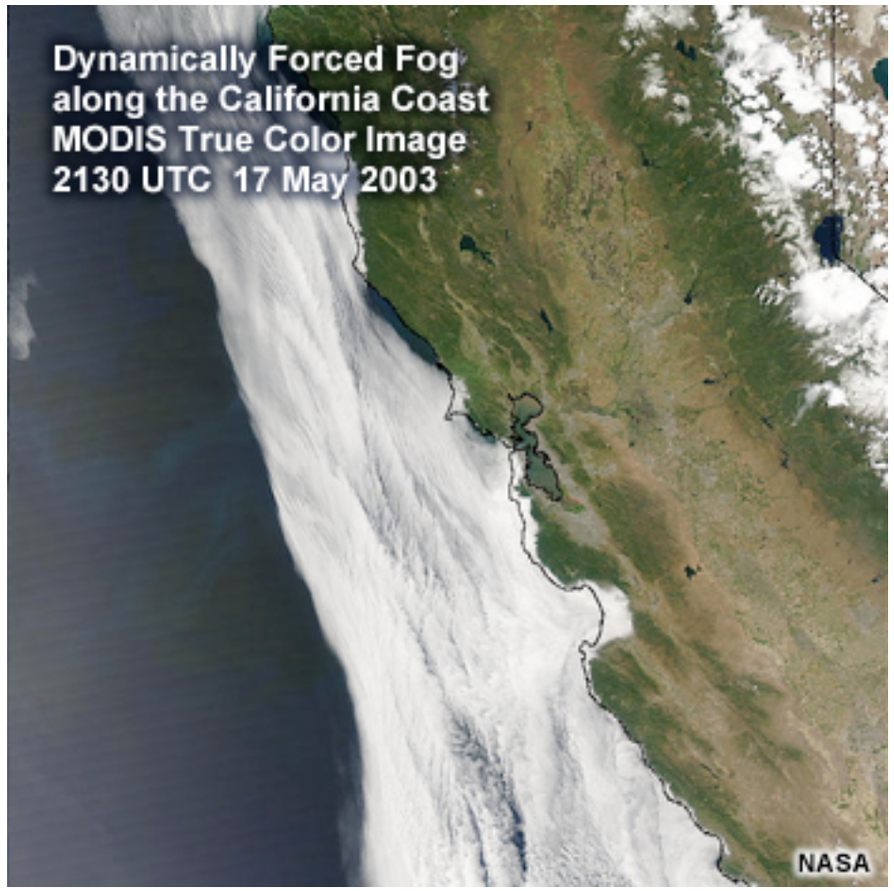
Radiation Fog in the Central Valley of California
MODIS True Color Image 2115 UTC 17 Jan 2003
NASA


Dynamically Forced Fog
along the California Coast
MODIS True Color Image
2130 UTC 17 May 2003
NASA

Dynamically Forced Fog

Dynamically forced fog is generated primarily by the cooling of moist near-surface air by dynamic processes. Dynamic processes may include advection and vertical mixing processes that lead to changes in the boundary layer temperature or moisture characteristics.

Perhaps most familiar is advection fog, which is a ground-based cloud caused by the cooling of an air mass to the saturation point as it moves over a colder surface. That surface may be cold ground, snow cover, water, or ice. Advective fog events in the marine environment tend to occur most often where a warm air mass moves over much cooler ocean water.

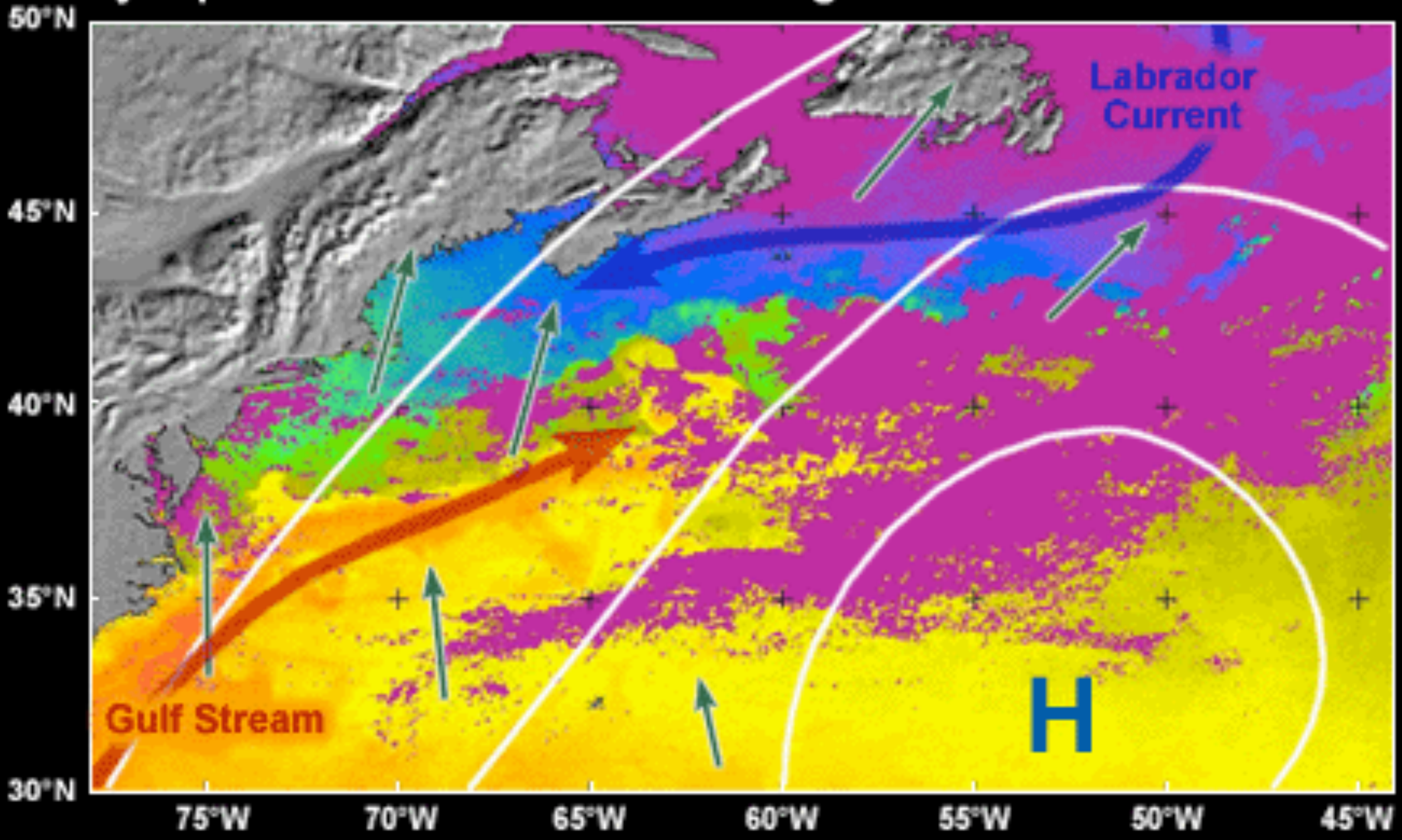
Dynamically Forced Fog

Regions where this is common include:

- Along the west coast of the North and South America and more infrequently along the west coast of Africa during the cool season
- Over the northeast and northwest Atlantic north of the Gulf Stream and over the northwest Pacific north of the Kuroshio Current during the warm season

Sharp Fog Bank Approaching La Jolla, CA

GOES-8 SST Image
Synoptic Pattern Conducive to Fog/Stratus

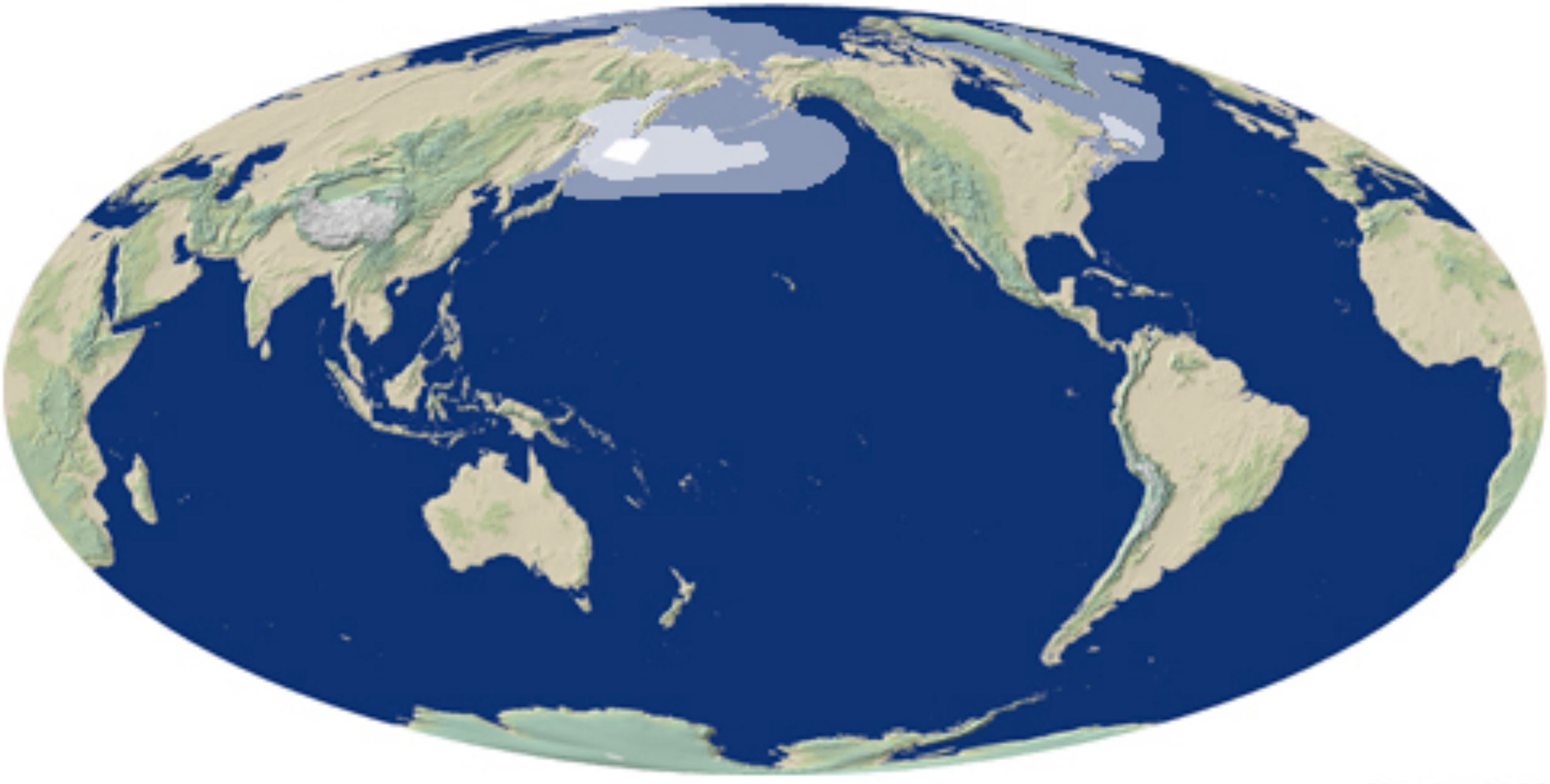


Sea Surface Temperature (°C)

-2 0 2 4 7 9 11 13 16 18 20 22 25 27 29 32

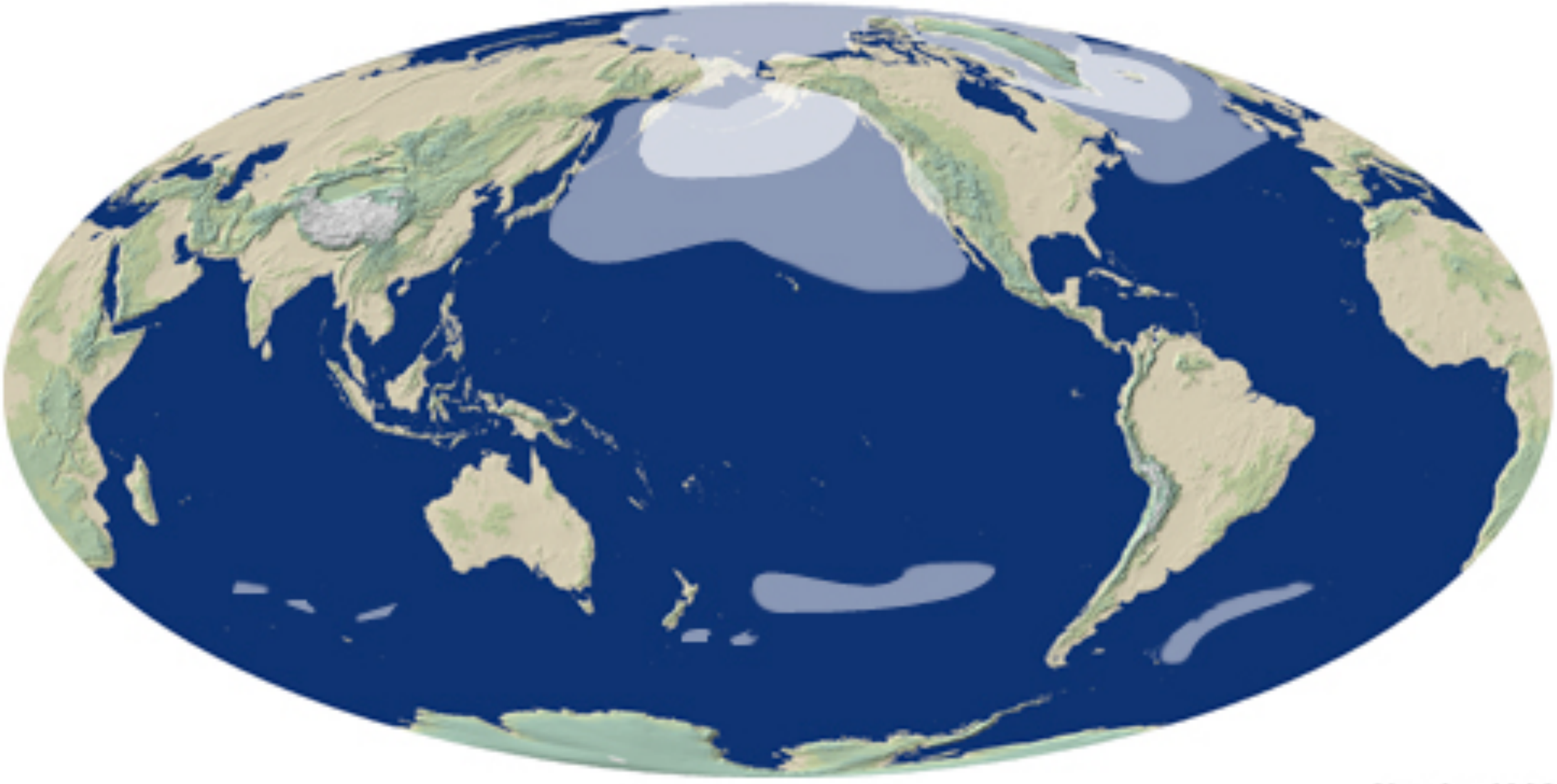
NOAA/CoastWatch

Daytime Frequency of Sky-Obscuring Fog Over the Ocean, Jun-Jul_Aug, Based On Ship Observations, 1954-1992

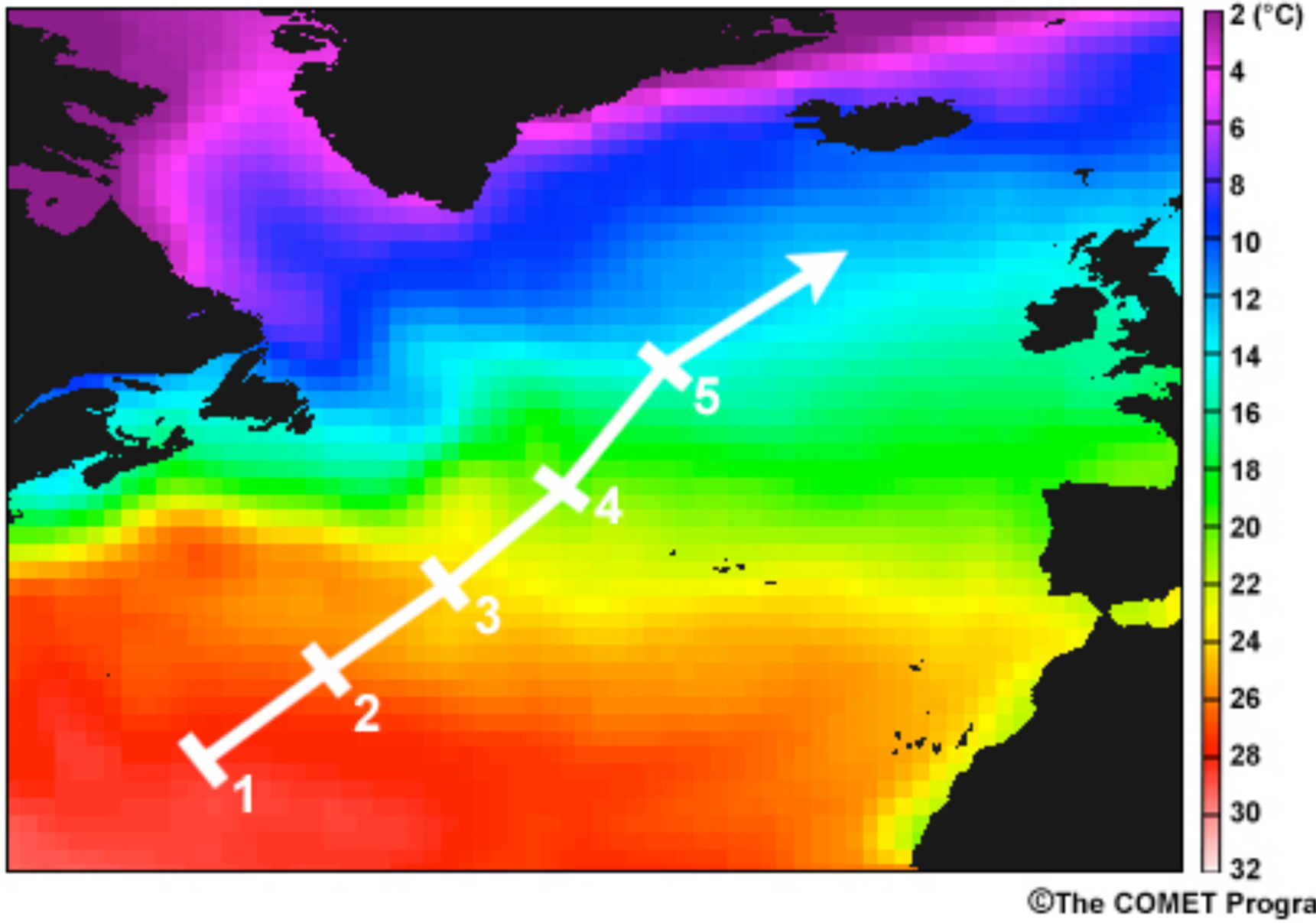


Norris, 1998

Daytime Frequency of Fair-Weather Stratus Over the Ocean, Based On Ship Observations, 1954-1992

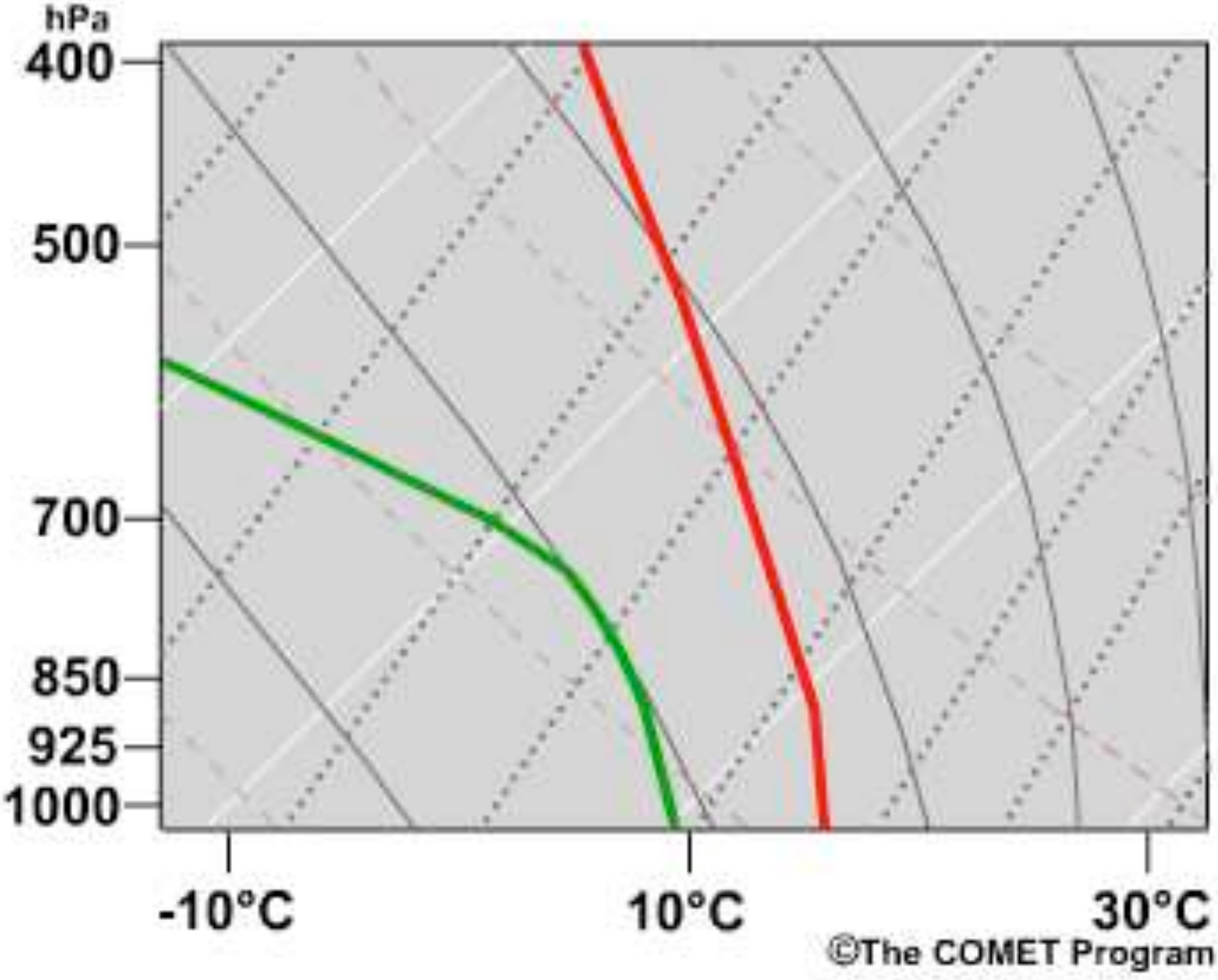


Norris, 1998

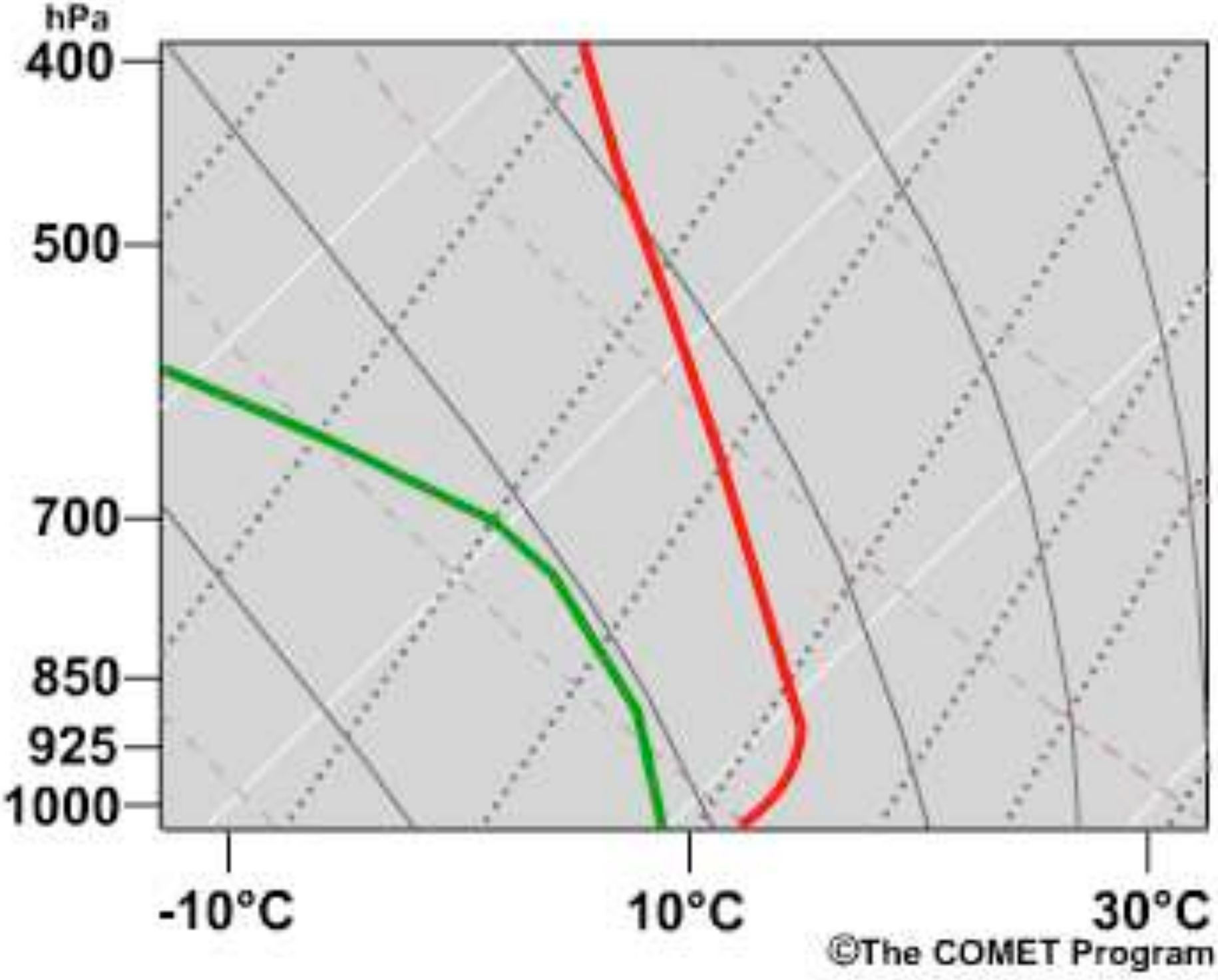


The skew-T sequence shown here is a conceptual example of how the boundary layer of an air parcel evolves over time as it moves over a cooler sea surface environment. A hypothetical air parcel trajectory is shown on the map by the white line. The numbers indicate the location of the air parcel for each highlighted stage.

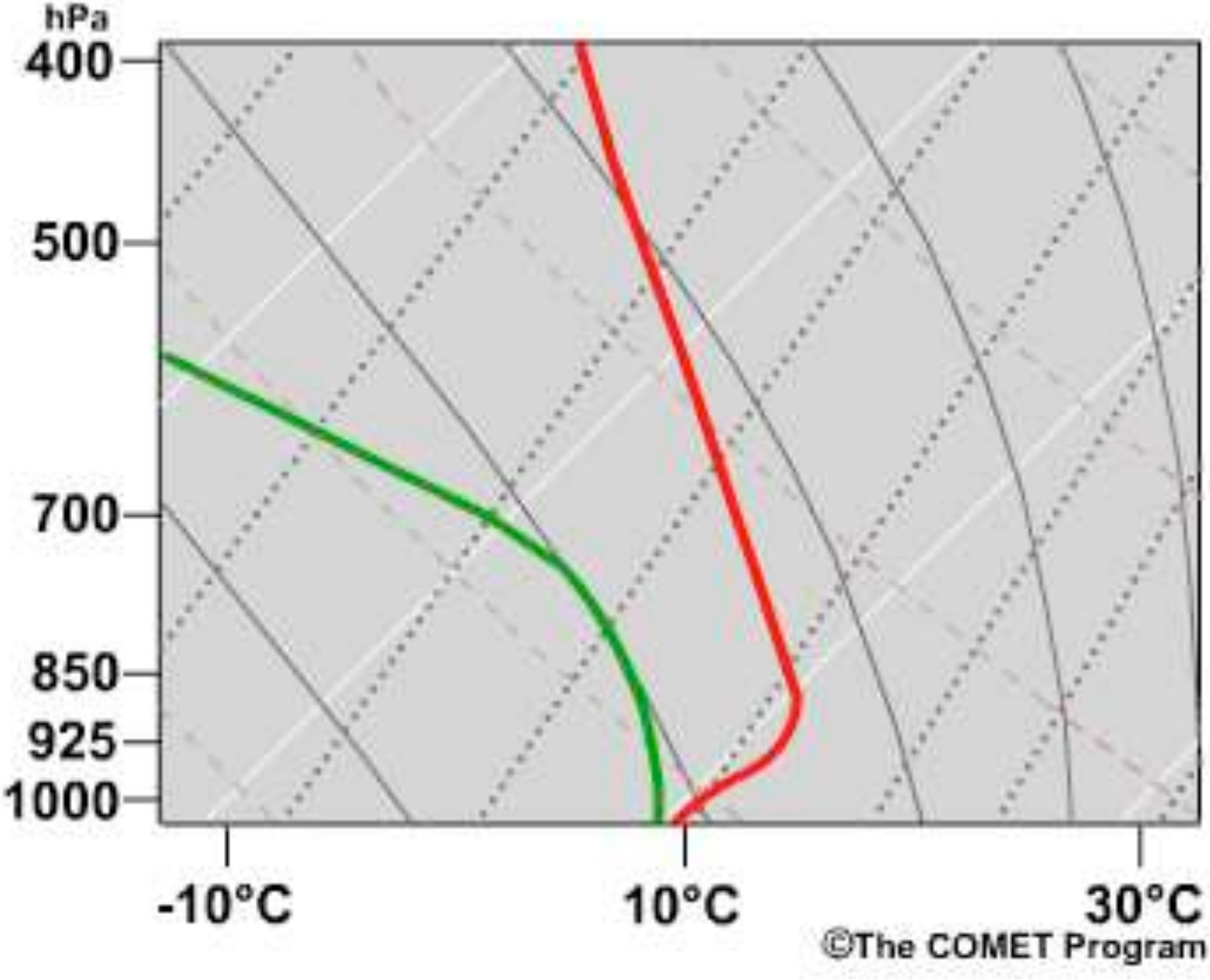
Boundary Layer Evolution for Advection Fog



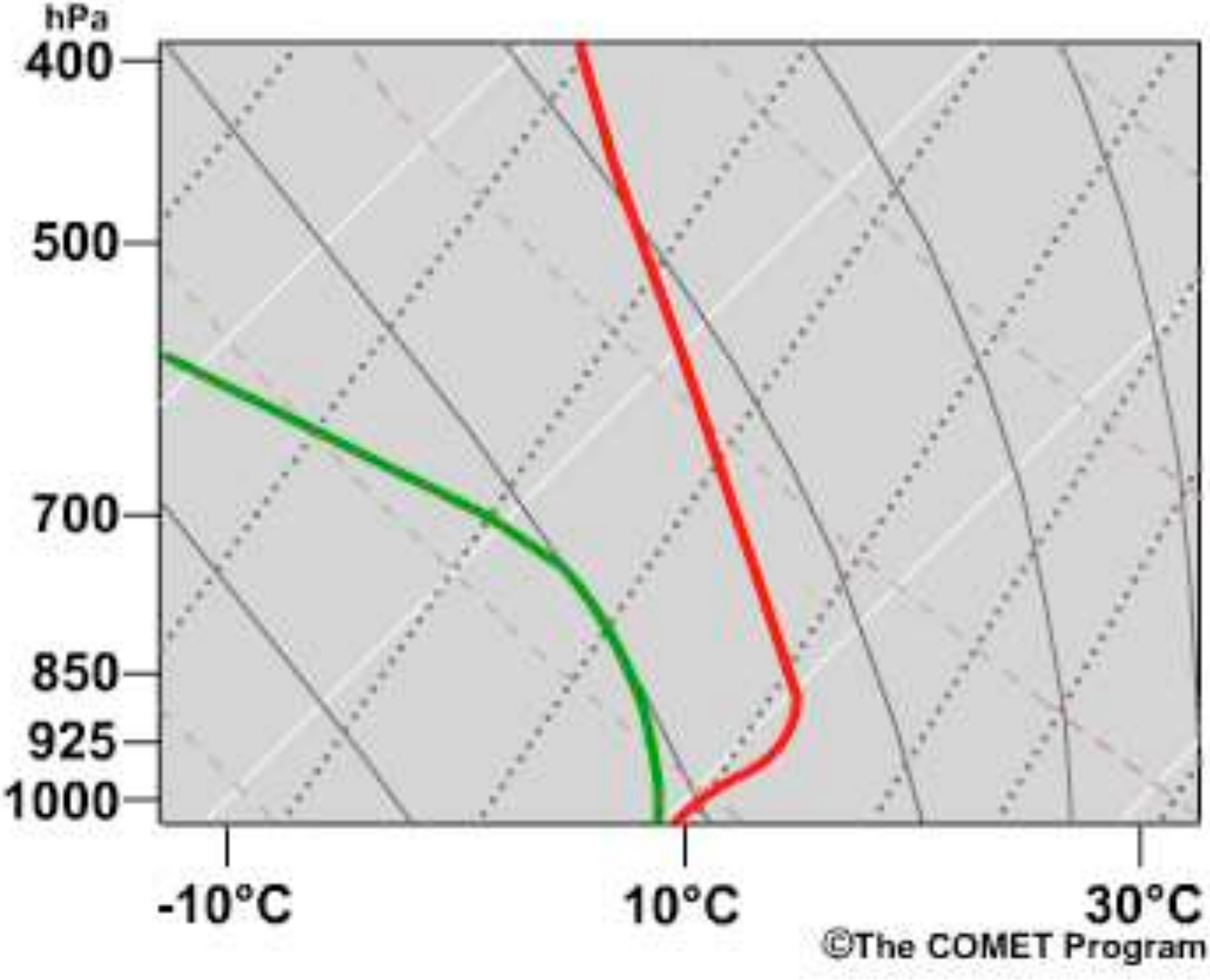
Boundary Layer Evolution for Advection Fog



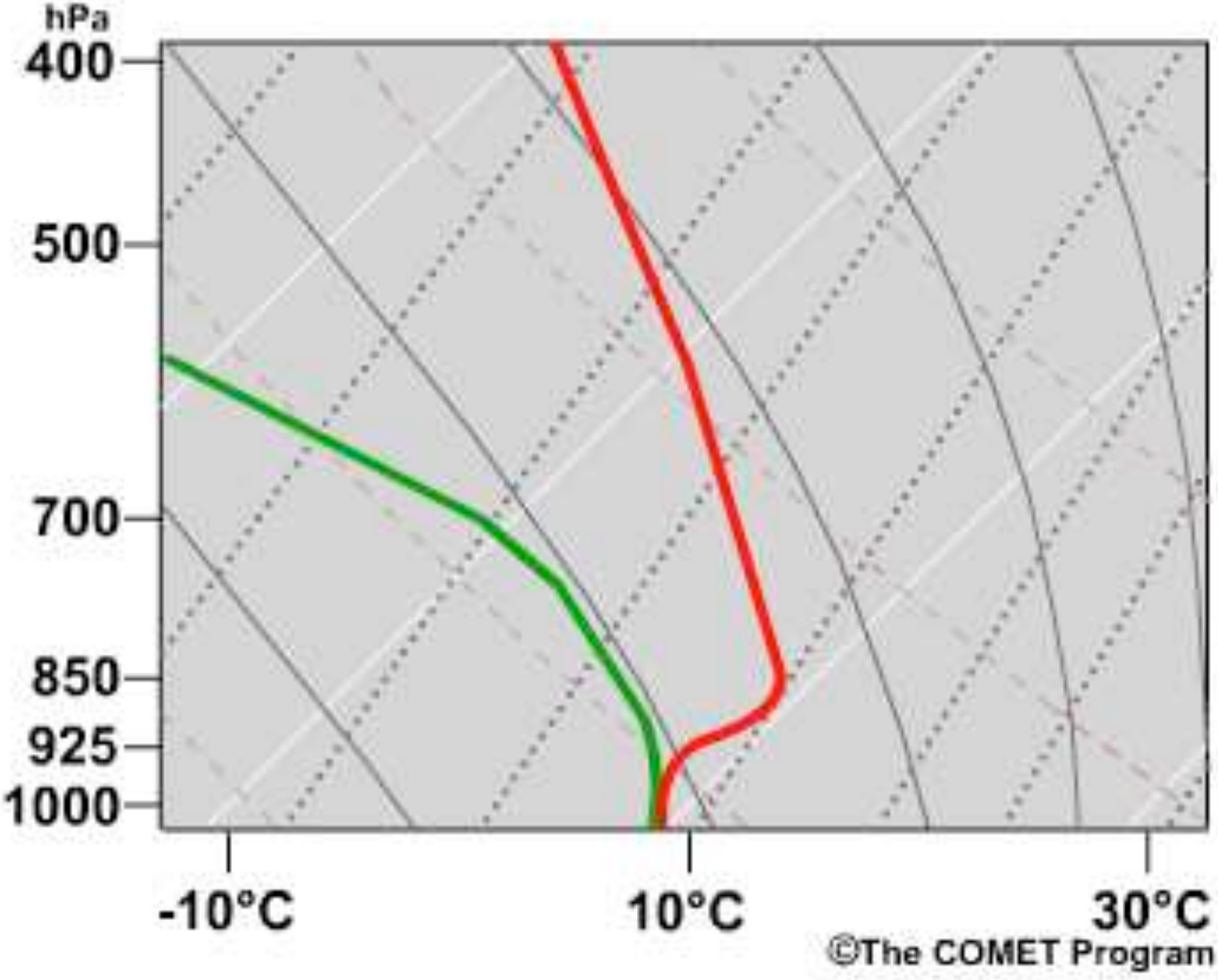
Boundary Layer Evolution for Advection Fog



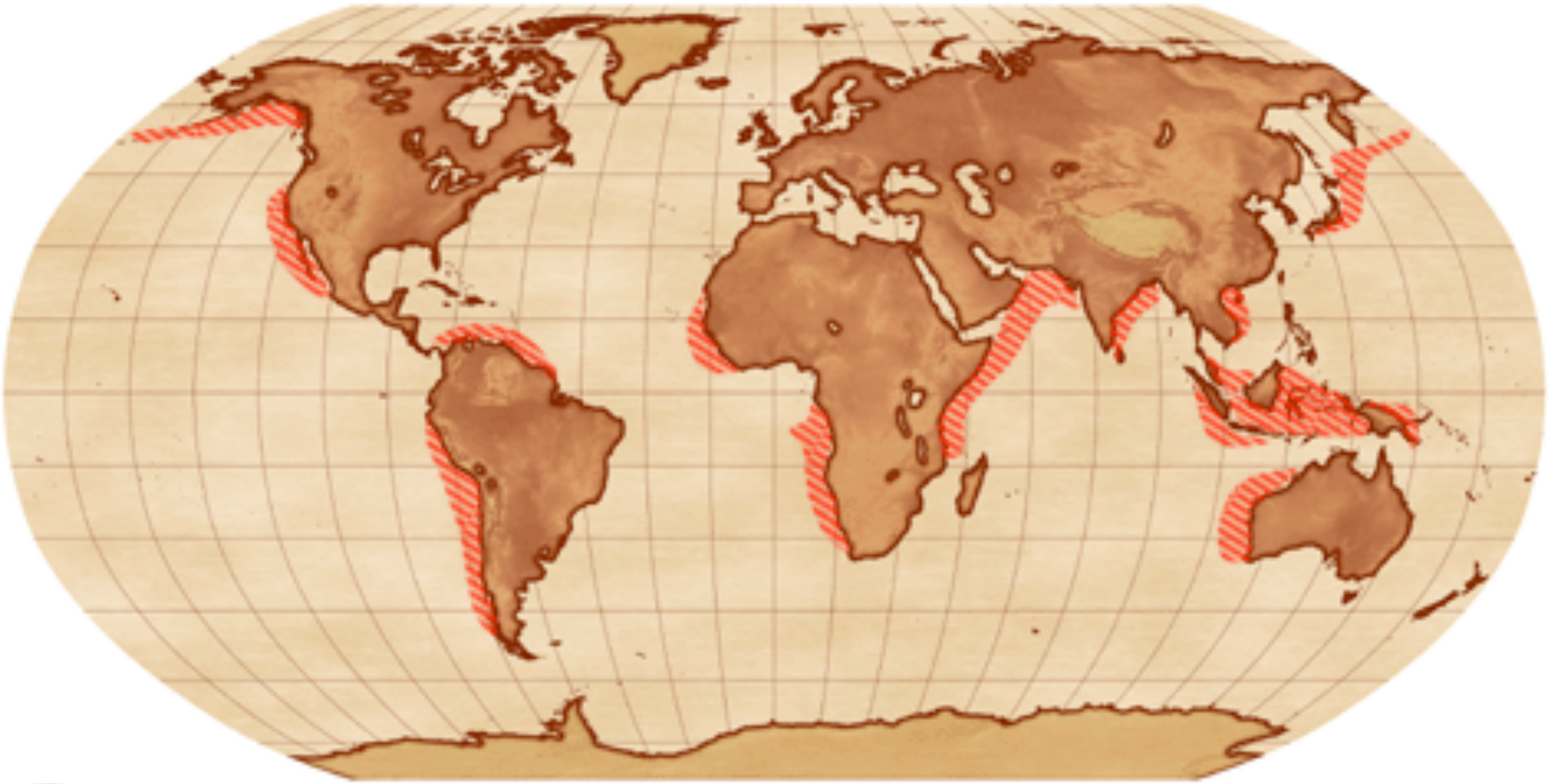
Boundary Layer Evolution for Advection Fog



Boundary Layer Evolution for Advection Fog



Main Regions of Upwelling in Coastal Regions Around the World



Upwelling

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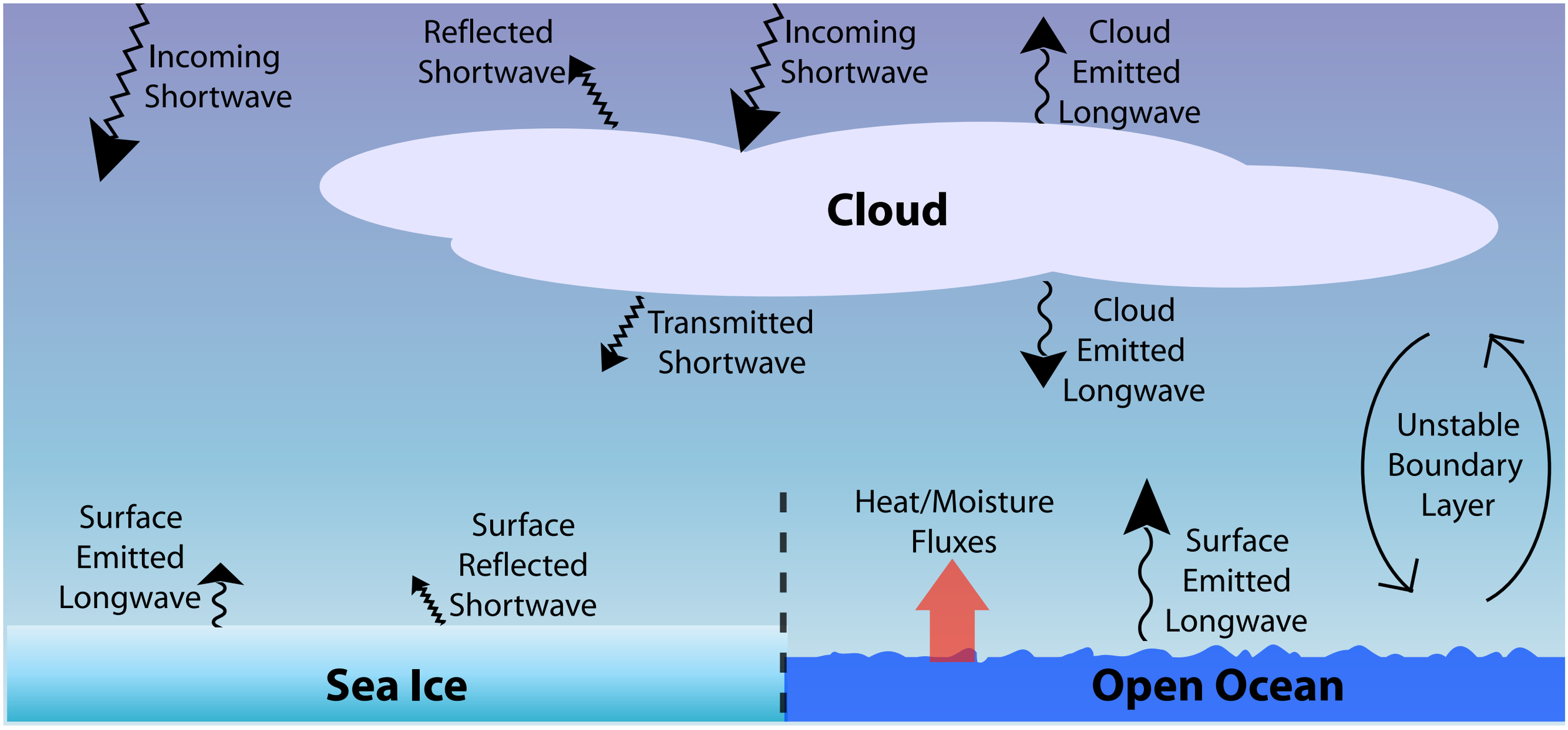


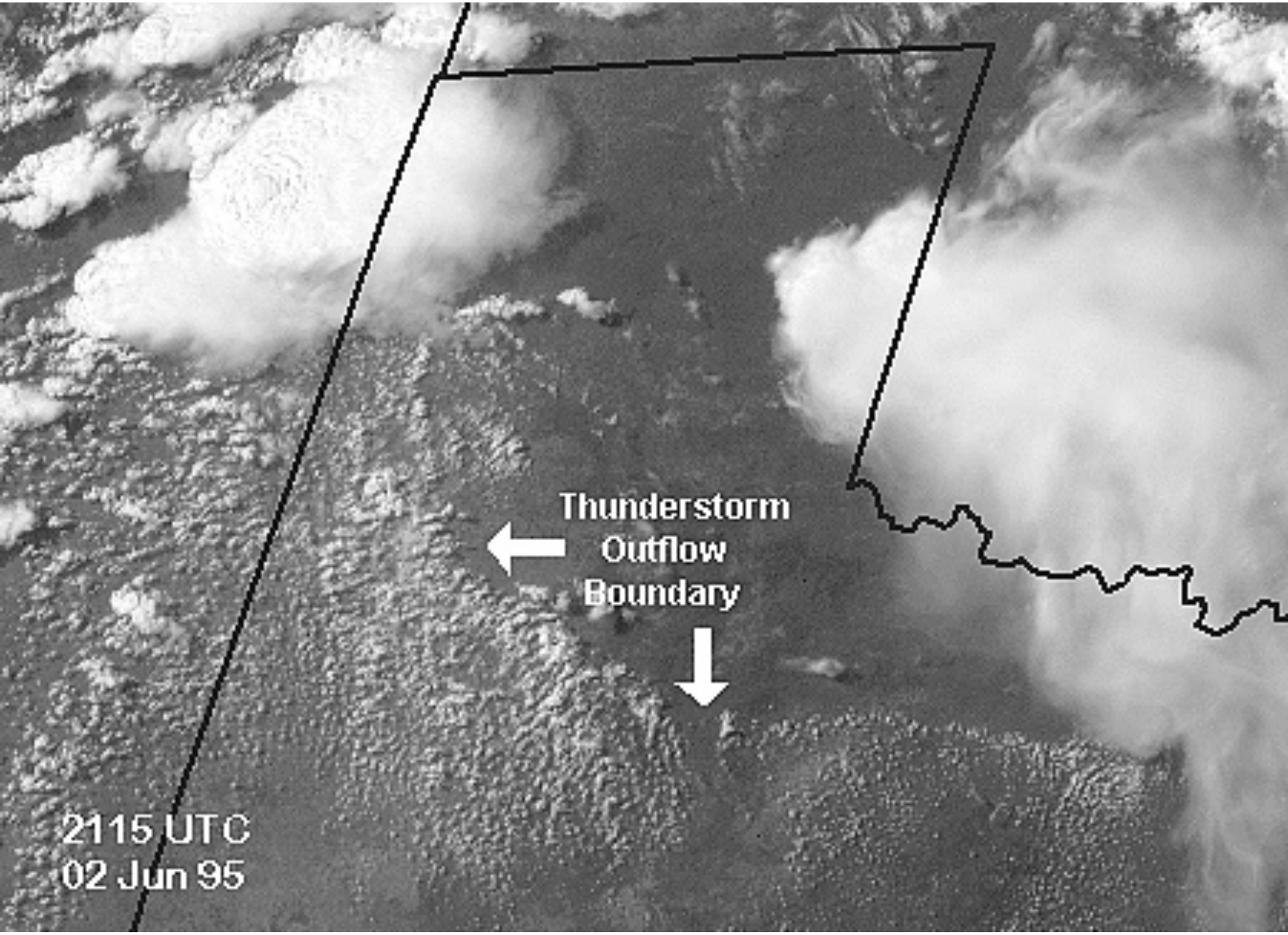
Figure 2.2: A simplified diagram of different modes of interaction between low clouds and ocean/ice surfaces in the Arctic.

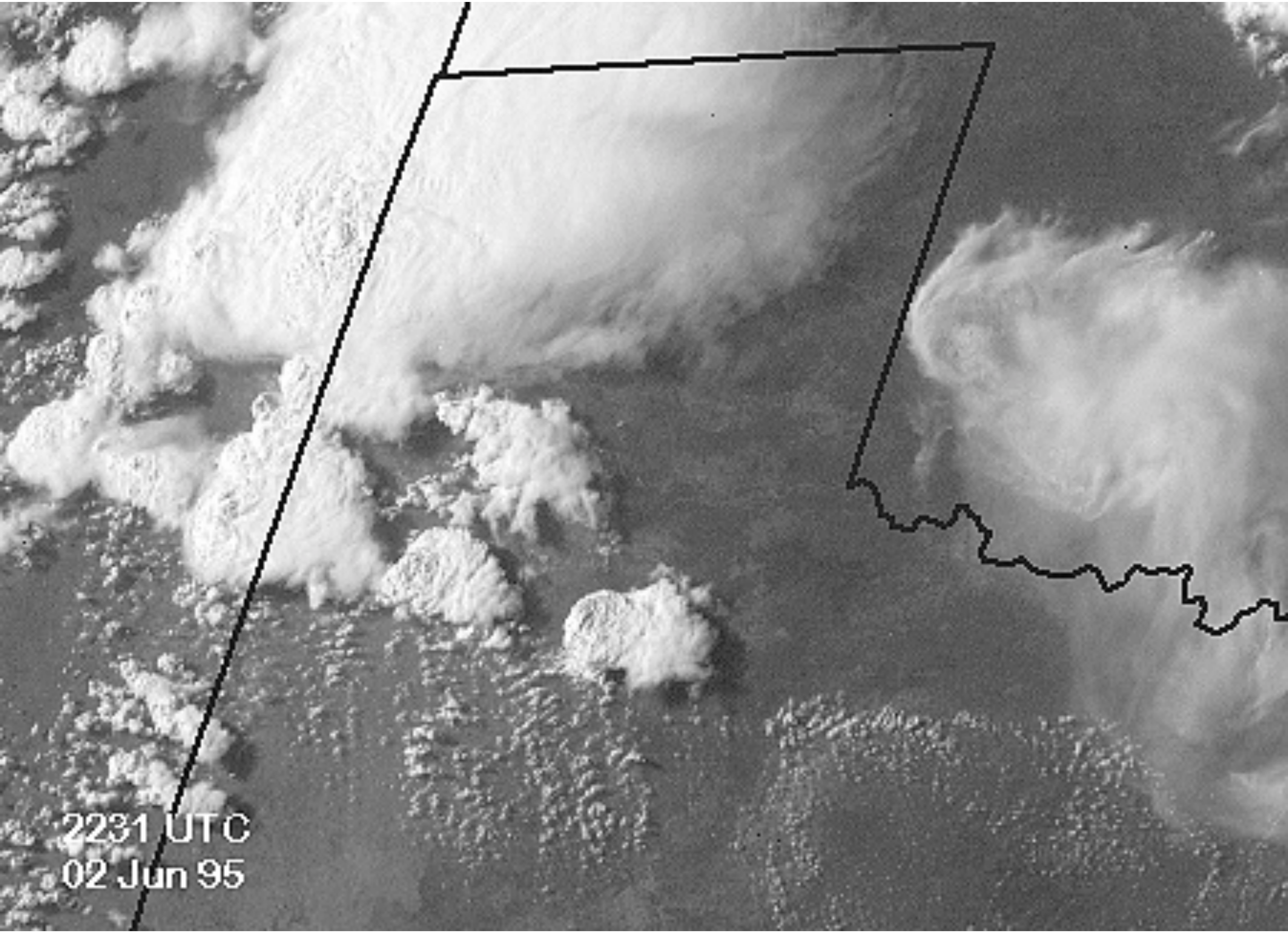
(de Boer 2009)

Arctic Leads

Lead and associated plume. Photo taken on BASE flight 16, October 12, 1994, over the Beaufort Sea.

Outflow from deep convection


Thunderstorm
Outflow
Boundary
2115 UTC
02 Jun 95


2231 UTC
02 Jun 95